Appendix B – Project Monitoring Plan

MARCH 2010

VOLTA WILDLIFE AREA
LEVEL 2 DIVERSIFICATION/ INCREMENTAL
LEVEL 4 DEVELOPMENT
PILOT PROJECT

1. Introduction

The Central Valley Project Improvement Act (CVPIA) of 1992 requires that the Department of the Interior acquire additional water supplies to meet optimal waterfowl and wildlife habitat management needs on refuges within California's Central Valley. These refuges collectively encompass National Wildlife Refuges, State Wildlife Management Areas and the Grassland Resource Conservation District (GRCD). The Bureau of Reclamation (Reclamation) is acting on behalf of the Department of Interior to fulfill these requirements.

Specific water management goals have been determined for two independent water supply levels termed Level 2 and Level 4. Level 2 refuge water refers to the average amount of water the refuges received between 1977 and 1984. Level 4 water is the amount of water required for full development of the refuges based upon the management goals of individual refuges and wildlife areas, consistent with CVPIA 3406(d)1 and (d)2. Incremental Level 4 water is the difference between full Level 4 and Level 2 water supply. Level 2 refuge water is normally utilized between September 1st and March 15th where as the Level 4 supply is used for summer brood habitat maintenance and spring/summer irrigations. In order to meet goals associated the CVPIA, Reclamation desires to increase the use of alternative refuge water supply sources by diversifying Level 2 refuge water supplies while increasing local sources of Incremental Level 4 refuge water supply. The Volta Wasteway Level 2 Diversification/Incremental Level 4 Development Pilot Project (Pilot Project) is a three-year demonstration project to evaluate the feasibility of groundwater utilization to diversify a portion of Level 2 supply and to supplement Incremental Level 4 supplies to wildlife refuges within California's San Joaquin (SJ) Valley.

Wetlands in the Central Valley are intensively managed to produce standing crops of plants and invertebrates with high value to wildlife. An effective method of wildlife food production is moist soil management. Moist soil management includes the timing of hydro-periods to optimize germination and plant growth. Grassland Water District (GWD) is responsible for the annual delivery of over 180,000 acre feet (AF) of water to seasonal and semi-permanent federal, state and private wetlands within the GRCD. The 180,000 AF of water that the GWD is responsible for delivering is composed of 125,000 AF of Level 2 supply, and 55,000 AF of Level 4 supply. In 13 of 14 years, Reclamation has been unable to provide the 55,000 AF of Incremental Level 4 water deliveries annually, as required by the CVPIA of 1992. In 2008 and 2009 the GWD received less than 24% of its obligated Level 4 surface water supply. Level 4 water supplies are critical for the optimization of seed and biomass production, the health and survival of locally breeding shorebirds and waterfowl, the state and federally threatened Giant Garter Snake (GGS) and the productivity of the largest of California's remaining wetlands.

The Pilot Project proposes the installation of two deep groundwater wells to develop up to 5,000 AF/year of new CVPIA Level 2 and Incremental Level 4 water supplies. The additional water developed through this Pilot Project would augment south of Delta shortages to the wetlands by annually supplying up to 2,500 AF of Level 2 and up to 2,500 AF of Incremental Level 4 supplies. Agricultural contractors would benefit by receiving up to 2,500 AF of Central Valley Project surface water annually made available by the groundwater pumping at Volta Wildlife Management Area (WMA).

Project Setting

The Volta Wasteway is located approximately six miles northwest of Los Banos in western Merced County (Figure 1). The Volta WMA is owned by Reclamation and has been operated by the California Department of Fish and Game (CDFG) since 1952 under a lease agreement. The Volta Wasteway is the primary supply canal for the Northern Division of the GRCD. Water is released from the Delta Mendota Canal (DMC) to the Wasteway through a variety of control structures for distribution throughout the Northern GRCD. The Wasteway conveys flows directly to the Volta WMA through lift pumps, and to the GRCD through releases out of control structures located in Pond 10[1]. Pond 10 structures are located at the terminus of the Wasteway and directly feed into the Santa Fe Canal Cross Channel, Mosquito Ditch and Malia Ditch. Wetlands in this region are typically flooded in late August to early September with flows in the Wasteway reaching 450 cubic feet per second (cfs). Wetland water elevations are maintained throughout the GRCD with maintenance flows from late October through the winter months to provide foraging and loafing habitat for waterfowl, shorebirds and other species. During the fall and winter maintenance flow periods, the Wasteway experiences flows up to 100 cfs. In the spring when soil temperatures are optimal for seed germination and successive plant growth, the wetlands are drained. Waters drained from these wetlands are conveyed to Mud Slough and Los Banos Creek which ultimately discharge to the San Joaquin River. Beginning in late April and continuing through the summer months, irrigation flows are delivered to the wetlands, filled and subsequently drained. During these periods the Wasteway can experience flows up to 150 cfs.

Project Objectives

The objectives of this Pilot Project are to: (1) develop a long-term groundwater supply that can be used to diversify CVP water supply sources and improve water supply reliability for CVP contractors, as well as supplementing Incremental Level 4 supplies for the SJ Valley Refuges, and (2) to confirm that the groundwater quality is acceptable for refuge use. Reclamation's goal is to pump up to 2,000 AF between September 1, 2010 and February 28, 2011 in year one, potentially producing up to 5,000 AF of groundwater per year (2011-2013) from this Pilot Project. Two production wells are to be installed and operated at maximum capacity (target of approximately 1,500 gpm per well) for three years. If target maximum capacity of 1,500 gpm per well is achieved, the two wells will produce 2,000 AF in 151 days of operation. Production well operation, timing and duration will be determined by Reclamation in coordination with GWD and CDFG based on water demand and both well and surface water quality. If the well operational goal of September 1, 2010 is achieved, as well as the target maximum capacity of 1,500 gpm, pumping could occur through January 29, 2011 but no later than February 28, 2011 in year one. In years two and three, Reclamation's goal is to pump up to 5,000 AF. The project water will be supplied to south of Delta refuges that are entitled to receive CVP water pursuant to Section 3406(d) of the CVPIA, show a demonstrated need or shortfall, and can receive the water by direct delivery from the Volta Wasteway.

[1] Pond 10 and Field 10 are used interchangeably throughout this document.

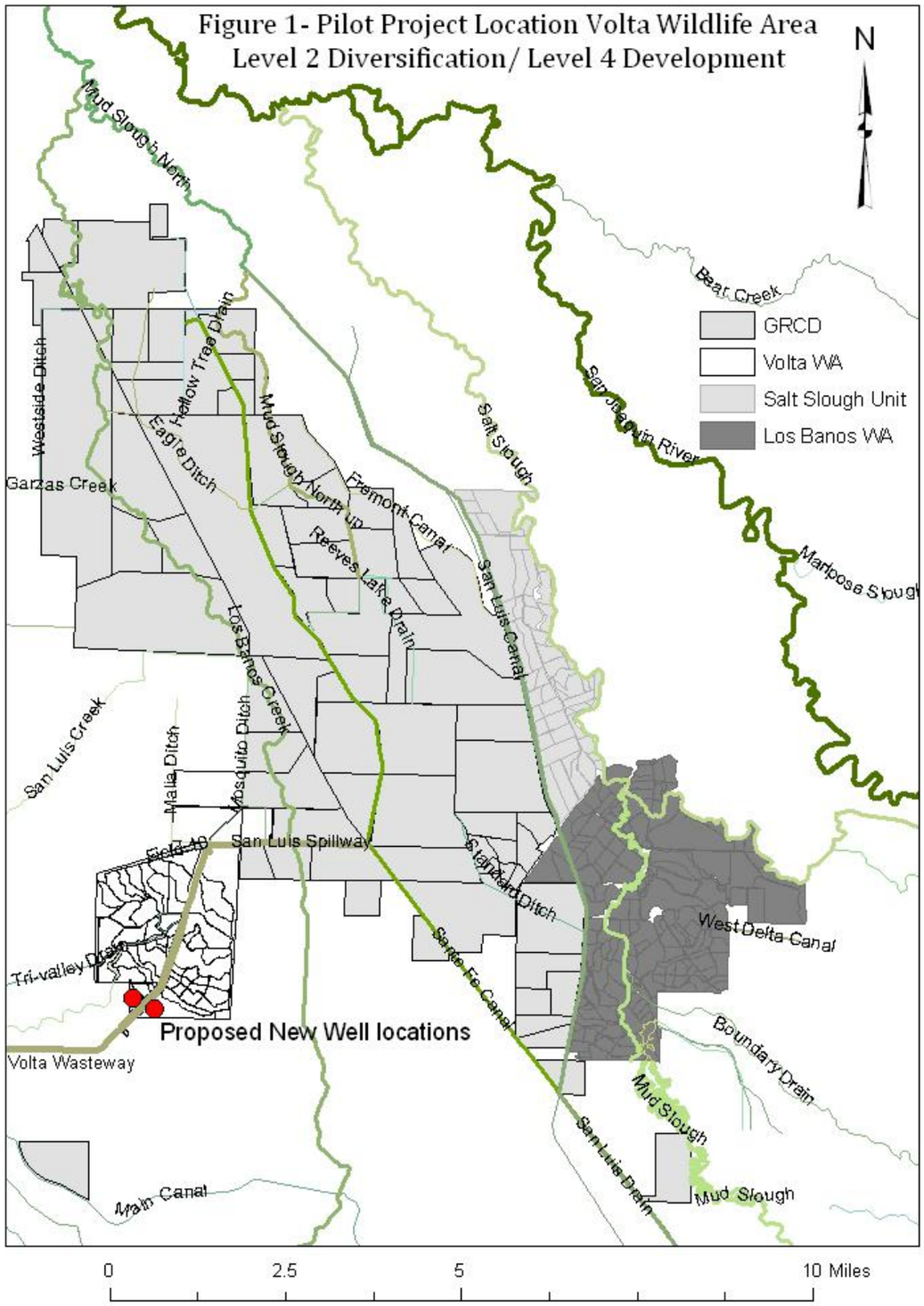


Figure 1- Pilot Project Location Volta Wildlife Area
Level 2 Diversification/ Level 4 Development
N
GRCD
Volta WA
Salt Slough Unit
Los Banos WA
Mud Slough North
Beat Creek
Salt Slough
San Joaquin River
Mariposa Slough
Westside Ditch
Hollow Tree Drain
Eagle Ditch
Garzas Creek
Mud Slough North up
Fremont Canal
Reeves Lake Drain
San Luis Canal
Los Banos Creek
Mosquito Ditch
San Luis Creek
Malia Ditch
Field 40
San Luis Spillway
Standard Ditch
West Delta Canal
Tri-valley Drain
Santa Fe Canal
Proposed New Well locations
Volta Wasteway
Boundary Drain
Mud Slough
San Luis Drain
Main Canal
Mud Slough
0
2.5
5
10 Miles

Project Viability

The key elements of project viability are the sustainable yield of the two new production wells to be screened below the Corcoran Clay and the quality of the water ascertained. Surface water and production well water quality monitoring will determine if and when adequate surface water dilution is available to meet State Water Resource Control Board's (SWRCB) water quality objectives outlined in the Central Valley Basin Plan and determine timing of well usage. This Project Monitoring Plan describes the data to be collected during the three-year demonstration period to address the project objectives and assess the long-term viability of the project.

2. Hydrogeologic Setting

The Volta WMA is located in the Merced sub-basin of the San Joaquin Valley basin. Groundwater supplies are present in unconsolidated deposits extending to 900 feet or more below grade. An upper, semi-confined aquifer extends from approximately 50 feet to 250 feet below grade. The Corcoran Clay, a regional aquitard that acts as a semi-confining unit, separates the upper semi-confined aquifer from deeper alluvial deposits, which form the lower confined aquifer. In the project area, the Corcoran Clay is found at approximately 250 feet to 450 feet below ground surface (bgs).

Wells screened in the semi-confined aquifer above the Corcoran Clay are likely to be in hydraulic communication with overlying surface water features, such as the Volta Wasteway and wetlands areas in the Volta WMA. Wells screened in the lower confined aquifer are not as likely to be in communication with surface water resources. Due to the potential mixing of waters between the two aquifer units, the Merced County Environmental Health Department (MCEHD) prohibits the construction of wells that are open to both aquifers within the same borehole.

Aquifer Yields

High-capacity wells screened in the lower confined aquifer in the vicinity of the Volta WMA reportedly yield from 1,000 to 1,500 gpm and as high as 2,000 gpm. Well yields are known to vary considerably in this area.

Groundwater Quality

The groundwater quality within the Merced sub-basin varies with location and depth both within the upper semi-confined and lower confined aquifers. In the lower confined aquifer, total dissolved solids (TDS) concentrations generally range from 100 to 3,600 milligrams per liter (mg/L). In two test holes drilled in the Volta WMA, TDS ranged from 300 mg/L (near the southern property boundary in close proximity to the proposed well locations) to over 1,500 mg/L (near the northern property boundary approximately 3 miles from proposed well locations). Wells operated by a local food processing plant yield groundwater from the lower confined aquifer with TDS concentrations ranging from 570 mg/L to 2,000 mg/L and electrical conductivity measurements ranging from 1,000 to 3,400 micro-Siemens (µS). Based on this limited data, and discussions with local drillers familiar with the area, it is evident that the water quality of the lower confined aquifer is variable throughout the Merced sub-basin.

According to MCEHD and the California Regional Water Quality Control Board, Central Valley Region (CRWQCB-SJR), constituents other than TDS that can affect water quality in the area include dissolved metals and nutrients.

3. Project Monitoring Plan Objectives

To meet the overall project objectives, this Project Monitoring Plan has the following objectives: (1) identify the data to be collected during the three-year Pilot Project to evaluate the overall project objectives; (2) specify the data collection procedures; and (3) clarify the responsibilities for data collection and interpretation for implementation of the Project Monitoring Plan. The information collected, interpreted, and reported in this monitoring program will address the project objectives for this Pilot Project.

There are four primary components that will be monitored as part of this program. These components are as follows:

- Hydrogeology – groundwater supply issues associated with the extraction and discharge of groundwater to the Volta Wasteway. This Project Monitoring Plan specifies the data to be collected to evaluate (1) the performance of the two new wells (i.e., well efficiency and long-term yield), (2) the affect the wells have on the surrounding area (i.e., radius of influence and potential interference between the two wells), and (3) whether there is any potential interconnection across the Corcoran Clay between the upper semi-confined and lower confined aquifers as well as within vertically separated water-bearing zones within the upper semi-confined aquifer.

- Water Quality – both ambient groundwater quality in the upper semi-confined and lower confined aquifers and potential changes to surface water quality in the Volta Wasteway due to the discharge of groundwater. This Project Monitoring Plan provides procedures for collecting and analyzing groundwater samples for a range of constituents to initially characterize and then monitor water quality during the three-year demonstration period.

- Biological – A collaborative research project, “Implementation of Priority 1, Priority 2, and Priority 3 Recovery Tasks for Giant Garter Snake (*Thamnophis gigas*) – Wetland Habitat Restoration and Giant Garter Snake Population Monitoring on the San Joaquin Valley’s Volta Wildlife Area, Merced, CA”, is being developed to better understand habitat requirements of the Giant Garter Snake (GGS).

- Ground Subsidence – the potential lowering of the ground surface elevation due to the removal of groundwater from beneath the Corcoran Clay. Subsidence monitoring procedures will be developed by Reclamation in consultation with the U.S. Geological Survey (USGS).

4. Implementation Responsibilities

The overall implementation of this Project Monitoring Plan is the responsibility of Reclamation. The specific responsibilities for implementation of the four main components noted previously are as follows:

- Hydrogeology – Each Volta well will have a cluster of monitoring wells that will be outfitted with vented pressure transducers permanently connected to a data logger and tethered EC probes with on board logging. The GWD Water Quality Monitoring Plan (WQMP) will be responsible for the collection and transmission of data to Reclamation (specifically a technical consultant from Lawrence Berkeley National Laboratory under contract to Reclamation; Reclamation contractor). The Reclamation contractor will be responsible for the interpretation, and reporting of the hydrogeologic data. The GWD WQMP will be supported by Reclamation for the collection of water level, groundwater pumping (i.e., pumping rate and total volume), and electricity use data.

- Water Quality – the GWD WQMP and Reclamation (specifically the Reclamation contractor) will share the responsibility for implementation of this component. The GWD WQMP will be responsible for the collection, storage and transmission of EC, Flow, and grab sample water quality data to the Reclamation contractor. The Reclamation contractor will be responsible for the interpretation and reporting of discrete groundwater and surface water quality data. The Reclamation contractor will be responsible for the selection of monitoring equipment to measure and log groundwater extraction rates of the water at the production wells. Each well will be outfitted with a digital output totalizing flow meter and a data logger to insure the preservation of data. The GWD WQMP will continue to be responsible for the collection, storage and transmission of data from the existing real time surface water monitoring station located downstream of Field 26. Reclamation will be responsible for the purchase of equipment at each production well. The GWD (with assistance of the Reclamation contractor for troubleshooting) will be responsible the installation and maintenance of the instrumentation for the monitoring stations at each production well.

- Biological - “Implementation of Priority 1, Priority 2, and Priority 3 Recovery Tasks for Giant Garter Snake (*Thamnophis gigas*) – Wetland Habitat Restoration and Giant Garter Snake Population Monitoring on the San Joaquin Valley’s Volta Wildlife Area, Merced, California” (Proposed Study). This Proposed Study is currently being considered for FY2010 funding under the authority of either the Central Valley Project (CVP) Conservation Program or the Central Valley Project Improvement Act (CVPIA) Habitat Restoration Program administered by United States Fish and Wildlife Service (USFWS) and Reclamation. The Proposed Study would gather data to better understand habitat requirements and utilization by GGS, which includes water quality monitoring, within the Volta WMA. If funding for the Proposed Study is approved, Reclamation would use the Proposed Study to meet any biological monitoring requirements for the Volta Wildlife Area Level 2 Diversification/Incremental Level 4 Development Pilot Project.

- Ground Subsidence – Reclamation (specifically the Reclamation contractor) will be responsible for coordinating with the USGS for the collection, interpretation, and reporting of ground subsidence data in the Volta WMA.

GWD will be responsible for maintaining the project water quality database, conducting initial quality assurance and quality control reviews of the data, and producing data transmittal reports to the Reclamation contractor and Reclamation. The Reclamation contractor will assist GWD with improvements to data management procedures over the project term. The GWD WQMP, with the assistance of the Reclamation contractor, will produce a final evaluation report, which will be delivered to Reclamation following completion of the demonstration project.

5. Scope of Work

The Pilot Project will be assessed by collecting hydrogeologic, water quality, biological, and subsidence data within the Volta Wasteway and at the Volta WMA, as described below.

Hydrogeology

Two water production wells are to be installed and operated at maximum capacity (target of approximately 1,500 gpm per well) for three years. If target maximum capacity of 1,500 gpm per well is achieved, the two wells will produce 2,000 AF in 151 days of operation. Production well operation, timing and duration will be determined by Reclamation in coordination with GWD and CDFG based on water demand, well and surface water quality, and habitat quality. Prior to the initiation of pumping in year one, baseline depth to water measurements will be taken manually using an electronic water level indicator in the two production wells. During the first month of operation, continuous hourly depth to water measurements will be taken in the two production wells. The GWD WQMP will also collect manual Quality Assurance (QA) depth to water measurements using an electronic water level indicator on a daily basis within the first week of operation, weekly within the first month of operation, and monthly during the operation period. Each well will have a cluster of monitoring wells that will be outfitted with vented pressure transducers permanently connected to a data logger and a tethered EC probe with on board logging. Continuous (hourly) data will be collected at the five Volta monitoring wells (2 clusters of wells; shallow semi-confined, deep semi-confined and sub-Corcoran). Monitoring well EC data will be downloaded on a monthly basis from the tethered probes. During the year one operation period (September 1, 2010-February 28, 2011), the GWD WQMP will collect continuous flow measurements (flow rates and totalizer digital output to data logger) from the two production wells. Hourly rainfall and evaporation pan data will be collected at a site closest to the production wells. Reclamation will obtain electricity use information throughout the operation period in bills received directly.

Water Quality

The GWD WQMP will collect baseline and interim water quality samples from the two production wells and five monitoring wells and submit them to an analytical laboratory for analysis. Water quality data from the monitoring wells will be coordinated to the extent possible with the USGS which has sampling equipment that will allow baseline water quality data to be collected. The baseline sampling event will occur prior to the initial start-up of the production wells and upon completion of the adjacent monitoring wells at the Volta site in conjunction with USGS. The baseline and interim sample collection and subsequent analysis of well discharge and surface water constituent concentrations will determine the minimum surface water volume required for adequate dilution of trace elements below SWRCB water quality objectives outlined in the Central Valley Basin Plan:

- **Selenium < 2.0 (µg/l),**
- **Boron < 2.0 (mg/l) March 15 – September 15,**

- **Boron < 2.6 (mg/l) September 16 – March 14**,

If inadequate dilution flows are available, GWD will cease the operation of the well until adequate dilution flow conditions return. The GWD WQMP will collect interim water quality samples from the two production wells throughout the duration of the project, following the schedule described below.

The analytical laboratory will analyze the baseline water quality samples for the following constituents:

- General minerals (anions, cations)
- Nitrate
- TDS & EC
- Trace Elements (Selenium, Boron, Arsenic, Uranium, Mercury)

Interim surface and production well water quality samples will be analyzed for general minerals, nutrients and TDS, unless the baseline sampling event indicates that metals or organics are of potential concern.

The GWD WQMP will collect water quality samples from the production wells on a monthly basis and from the Volta Wasteway on a weekly basis, immediately upstream and downstream of the production well discharge points. Water quality samples will be submitted to an analytical laboratory for the analyses described above during year one at which time an assessment of required sample frequency will occur based on the variability of the surface and ground water trace element concentration. Pumping will occur during any duration that well water quality is found to have a lower EC and lower trace element(s) concentration than the surface water quality being discharge into.

Volta Wildlife Area Level 2 Diversification/Incremental Level 4 Development Pilot Project- Monitoring Plan - Surface Water Quality Degradation Avoidance Protocol

A Surface Water Quality Degradation Avoidance Protocol (SWQDAP) has been developed by the Grassland Water District (GWD), CDFG, the SLDMWA, and the Reclamation for the Volta Wasteway related to the operation of two deep wells located within the Volta WMA under the Pilot Project.

Surface water quality (EC - Electro-Conductivity µs/cm) in the Volta Wasteway is seasonally variable ranging from 389 µs/cm (observed in September of 2006), to 2460 µs/cm (observed in August of 2007). To account for this high variability in seasonal water quality a SWQDAP was developed to preserve periods of relatively good water quality (seasonally low EC) that a static trigger would otherwise evade (See Figure 3.0). The SWQDAP is based on historical weekly EC data collected by the CDFG from April of 2005 through December of 2009 using a calibrated Myron ULTRAMETER 6P. Summary statistics including the Monthly Average EC and SE (Standard Error) is the foundation for the development of the SWQDAP (See Appendix C, Figures 1.0 and 2.0).

The Max EC 2005-2009 heading in the attached Figure 2.0 (Appendix C) is the Maximum Observed Monthly Average EC from 2005-2009 and is the Caution Threshold where pumping would proceed with caution. The SE heading in Figure 2.0 (Appendix C) is the corresponding SE from the Max Observed Monthly Average EC 2005-2009. The MAX EC + SE 2005-2009 heading in Figure 2.0 (Appendix C) is the sum of the MAX EC and corresponding SE and is the STOP THRESHOLD and determines when pumps will be shut off, effectively avoiding the elevation of salt beyond recent historical salt conditions observed due to the pumping associated with this pilot project (See Appendix C, Figure 4.0).

Production well operation, timing and duration will be determined by GWD in coordination with CDFG based on water demand and both well and surface water quality in the Volta Wasteway and receiving wetland habitat. During well operation weekly EC grab sample data as well as continuous real time EC data will be collected downstream of the discharge points of the two production wells at the CDFG Volta Bridge grab sample data collection point. Analysis of the EC data will occur on a weekly basis and assess the Average EC of the previous four week period to determine the operation or non-operation of the two production wells in the week to come (See Figure 5.0). If the four week running average EC is below the Monthly MAX EC STOP threshold for the operational period in question pumping will occur. If the four week running average EC is above the Monthly Max EC threshold for the operational period in question pumping will not occur. A conditional real time EC data analysis will occur if the 4 week running average EC enters the caution threshold. This conditional real time EC data analysis will occur on the scheduled weekly interval but will analyze continuous 15 minute EC data to characterize variability in EC that may not be represented in the weekly grab sample EC data. A conditional real time EC data analysis will also occur if the 4 week running average EC enters the STOP threshold. This conditional real time EC data analysis will occur on a bi-daily basis and will analyze continuous 15 minute EC data to characterize variability in EC that may not be represented in the weekly grab sample EC data and enhances the responsiveness of the operations associated with the STOP threshold (See Figure 6.0).

The SWQDAP was developed by the analysis of historic grab sample EC data collected in proximity to the proposed project location. This method should not be applied to any other conveyance system. Data utilized in the same manner must encompass a full wet-dry cycle to accurately represent annual variability in water quality and undergo a rigorous quality assurance protocol to insure that the data is representative of surface water quality conditions. The SWQDAP is a method to minimize surface water quality degradation specifically for this Pilot Project.

The Reclamation contractor will provide oversight for the collection of water quality data from the two production and six monitoring wells continuously logged on an hourly basis (EC and temperature). The GWD WQMP will also collect downstream surface water quality data (EC, Temp, and Flow) from the real time monitoring station currently in use in the Volta Wasteway. Data will be stored in a database and transmitted monthly by e-mail to the Reclamation contractor.

Biological Monitoring

Reclamation, in conjunction with CDFG, will develop a biological monitoring program to collect appropriate physical and biological data in the project area for GGS.

Ground Subsidence

The Reclamation contractor will coordinate with the USGS to collect ground surface elevation data (INSAR time-series data) in the vicinity of the two production wells to assess the potential for land subsidence due to groundwater extraction. A schedule for collection of the subsidence data will be determined. Reclamation will provide USGS data to the Authority, GWD WQMP and CDFG for their evaluation.

6. Field Data and Sample Collection

The various team members will strive to minimize hand-entered data and provide electronic data that can be efficiently entered into project database housed at the GWD in a timely fashion. Electronic forms will be developed and used to collect basic site information at each site visit. Data quality assurance checks will also be entered into the project database. This database will be backed up and shared with the Reclamation contractor monthly or an as needed basis. The GWD WQMP will record hydrogeologic and well sampling information on project-specific electronic field logs, included in Appendices A and B. These data will also be entered into the project database.

Hydrogeology

Monitoring wells will be outfitted with vented pressure transducers and the data reported to a data logger (logged hourly) installed adjacent to each well. Monitoring wells will also be outfitted with tethered EC probes with on board logging and down loaded on a monthly basis. The GWD WQMP will collect manual QA depth to water measurements using an electronic water level indicator on a daily basis within the first week of operation, weekly within the first month of operation, and monthly during the operation period. The GWD WQMP will all collect depth to water measurements, no less than 24 hours after the onset of operation and no less than 24 hours after the end of the operational period, to characterize ground water recovery and residual drawdown of the two production wells. Each production well will be outfitted with a totalizing flow meter, solar powered data logger and security enclosure. Flow data will be logged continuously on an hourly basis. Prior to collecting the water level measurements from each production well during the pumping season, the flow rate, total flow, and electric meter reading will be recorded in the electronic field log. The procedure for groundwater level measurement and the project field log form can be found in Appendix A. If early monitoring events indicate greater variability than expected, additional monitoring events may be added.

Water Quality

The GWD WQMP will collect water samples for laboratory analysis from the two production wells on a monthly basis, and the Volta Wasteway (2 locations - upstream and downstream of production well discharge points) prior to the first day of pumping (baseline sampling event) and weekly during the pumping duration. At the end of the year one pumping period an assessment of required sample frequency will occur based on the variability of the surface and ground water trace element concentration. If there is little change, water quality sampling will be performed semi-annually. During year two of the demonstration project, the GWD WQMP will collect water quality samples from the two production wells and the Volta Wasteway (2 locations) in October and May unless data from year one reveals high variability in constituent analysis. However, if early monitoring events indicate greater variability than expected, additional monitoring events may be added. The intent of the water quality program is that it be adaptive – that it adequately characterizes ambient water quality in the groundwater and transients in water quality with the onset of groundwater pumping. Sampling procedures are briefly described below. A detailed description of the sampling procedures, monitoring well purging requirements and a project field log form are included in Appendix B.

7. Data Collection and Management

The GWD WQMP will collect data as described previously throughout the project duration (Table 1). Field data will be entered into a master project database and protocols developed for electronic sharing of this data. The Reclamation contractor will provide technical assistance to improve the database management system through the course of the study. Electronic data will be obtained from the analytical laboratory, the monitoring stations, the USGS INSAR database, and local weather station and this will also be entered into the master project database. Field data will include water level and field water quality measurements, well purging and sampling information, and environmental and biological observations. These data will also be entered into the master project database.

Electronic Data

Throughout the duration of the project, electronic data will be downloaded from multiple sources as described above. Each data source will have a unique set of download and data quality control procedures. The specific procedures are provided below.

- Laboratory data – will be uploaded to a data validation program to ensure completeness. Once the data has been electronically validated, the data file will be uploaded to the project-master database. A summary report will be generated and validated against the PDF file provided by the laboratory. The Reclamation contractor will be provided with copies of the validated quarterly via e-mail.

- Real Time Monitoring Station data – will be downloaded by the GWD WQMP as an ASCII text file. This data will be uploaded to a data quality validation program and adjustments made to the data to match QA checks. The QA validated data will be uploaded to the master project database and a summary report will be generated. The summary report will be provided by the GWD WQMP to the Reclamation contractor.

- USGS INSAR data – the USGS will provide both raw and interpreted INSAR data to the Reclamation contractor for dissemination to the GWD and the larger project team. Data formats will be chosen so that the data is compatible with the master project database housed at the GWD.

- Weather data – will be downloaded via the internet from a local weather station. The data will be exported to both a PDF file and an ASCII text data file and uploaded to the master project-database.

Field Data

Field notes and photographs (as applicable) will be entered into the master project database. Depth-to-water and field water quality measurements will also be entered into the database. A summary report will be generated and validated against the hard copy field data sheets. Digital images of site photographs collected throughout the project duration will be stored in the electronic database and linked to a GIS map of the project area. Backups of the master project database will be performed weekly. These data will be provided to the Reclamation contractor quarterly.

TABLE 1 - Field Data Collection Schedule & Responsibility

	YEAR							
	1				2		3	
FIELD DATA COLLECTION	**Week 1**	**Month 1**	**Operation (TBD)**	**Non-Op (TBD)**	**Operation (TBD)**	**Non- Op (TBD)**	**Operation (TBD)**	**Non- Op (TBD)**
HYDROGEOLOGY								
Water Levels (LOGGING)	Hourly (GWD)	Hourly (GWD)	Hourly (GWD)	Hourly (GWD)	Hourly (GWD)	Hourly (GWD)	Hourly (GWD)	Hourly (GWD)
Water Level (MANUAL QA)	Daily (GWD)*	Weekly (GWD)	Monthly (GWD)	(GWD)**	Monthly (GWD)	(GWD)**	Monthly (GWD)	(GWD)**
Flow Rate & Total Flow	Hourly (GWD)	Hourly (GWD)	Hourly (GWD)	NA	Hourly (GWD)	NA	Hourly (GWD)	NA
WATER QUALITY								
Production & Monitoring Wells (EC)	Hourly (GWD)	Hourly (GWD)	Hourly (GWD)	NA	Hourly (GWD)	NA	Hourly (GWD)	NA
Production Wells (LAB ANALYSIS)	B* (GWD)	(GWD)	Monthly (GWD)	NA	FALL SPRING (GWD)	NA	FALL SPRING (GWD)	NA
Surface Water (EC) Up/ Down Stream	Daily (GWD)	Weekly (GWD)	Weekly (GWD)	NA	Weekly (GWD)	NA	Weekly (GWD)	NA
Surface Water (LAB ANALYSIS)	B* (GWD)	Weekly (GWD)	Weekly (GWD)	NA	FALL SPRING (GWD)	NA	FALL SPRING (GWD)	NA
BIOLOGICAL	TBD (Reclamation)				TBD (Reclamation)		TBD (Reclamation)	
SUBSIDENCE	USGS -Reclamation (LBNL)				USGS -Reclamation (LBNL)		USGS -Reclamation (LBNL)	

Week 1/ Month 1 represents the first week/ month of well (operation goal September 2010)

Operation Period- Up to 12 Months (TBD), Non Op (Operation) period TBD (to be determined)

Hydrogeology- Water Levels (Production & Monitoring well depth to water- Continuous logged hourly)

Hydrogeology- Water Levels (Manual QA) Production & Monitoring well using a EWLI

Hydrogeology- (GWD)* = Groundwater Recovery & Residual Drawdown ($\geq$24 hrs after pumping has STARTED)

Hydrogeology- (GWD)** = Groundwater Recovery & Residual Drawdown ($\geq$24 hrs after pumping has FINISHED)

Hydrogeology - Flow Rate & Total Flow -Continuous logged hourly

B* = Baseline Data Collection- GWD WQMP will collect samples prior to initiation of pumping in year 1

Water Quality- Production & Monitoring Well EC- Continuous (hourly) logging

Water Quality – Production Well Lab Analysis (Monthly in Year 1, semi-annual (Fall/ Spring) in years 2 & 3)

Water Quality- Surface Water Lab Analysis (Weekly in Year 1, semi-annual (Fall/ Spring) in years 2 & 3)

- Production Well Sampling- Baseline production well grab sampling will be conducted in conjunction with USGS during the installation of each well. Interim, monthly water samples from the two production wells will be collected using the sample tap installed at each wellhead. To collect a sample, staff will open the tap and allow a minimum of 10 gallons of water to run through the tap. Once the sample tap has been purged, and clear water is being produced, staff will fill the laboratory-supplied sample bottles directly from the tap. Field water quality parameters (temperature, pH, and EC) will be measured during the sample collection process. Samples will be stored in a cooler containing ice until they are delivered to the analytical laboratory. Temperature and EC will be continuously logged on an hourly basis throughout the duration of the project.

- Monitoring Well Water Quality- Tethered EC probes will continuously log data throughout the duration of the project and will be manually downloaded on a monthly basis.

- Volta Wasteway Sampling- In year one, weekly water samples will be collected from two fixed locations in the Volta Wasteway (upstream and downstream of the groundwater discharge locations). Samples will be collected using a sample bottle connected to an extension pole. The water will then be transferred to laboratory-supplied sample bottles. Samples will be stored in a cooler containing ice until they are delivered to the analytical laboratory. Field water quality parameters will be measured during the sample collection process.

Biological Monitoring

Reclamation, in conjunction with CDFG, will be responsible for the collection, interpretation, and reporting of GGS habitat (physical and biological) information in and around the Volta Wasteway and the Volta WMA.

Land Subsidence

The USGS will collect ground surface elevation data (INSAR time-series data) in the vicinity of the two production wells in accordance with the plan to be developed by Reclamation.

Operational Information

Production well operation, timing and duration will be determined by GWD and CDFG based on water demand, well and surface water quality, and habitat quality. In year one, pumping will occur between September 1, 2010 and February 28, 2011 and will not exceed 2,000 AF. If the well operational goal of September 1, 2010 is achieved, as well as the target maximum capacity of 1,500 gpm, pumping could occur through January 29, 2011 but no later than February 28, 2011 in year one. In years two and three, Reclamation's goal is to pump up to 5,000 AF.

During sampling or monitoring events, the status of the production wells, monitoring wells, and operating equipment will be recorded in an electronic form and photo documented periodically. These data will also be entered into the project database. Broken, damaged, vandalized and/or otherwise inoperable equipment and appurtenances will be immediately reported to Reclamation by the person who observed the damage. Field records will also note any maintenance performed on the equipment.

The condition of the erosion control features will also be recorded and photo-documented during each sampling or monitoring event. As part of the habitat observations to be conducted, appropriate environmental conditions of the Volta Wasteway and the Volta WMA will be photo-documented.

8. Reporting

The schedule for implementing the Project Monitoring Plan is based on the assumption that the two production wells and five monitoring wells will be constructed and operational by August 2010, with the first month of operation September 2010. The GWD WQMP, with the assistance of the Reclamation contractor, will submit annual reports to Reclamation and CDFG in March 2011 and March 2012 following the completion of pumping in January of each year. The final project evaluation report, which will transmit all project data and provide an evaluation of the three-year demonstration project, will be submitted to Reclamation, USFWS and CDFG in April 2013, following completion of the monitoring program.

Data transmittal reports will include a brief description of the activities conducted during the previous pumping season, and a summary of the data collected. The data transmittal reports will also identify work that deviated from the planned activities, and provide an explanation for the deviation. A summary of the activities to be conducted during the subsequent year will also be provided.

The final report to be delivered to Reclamation, USFWS and CDFG will summarize the data collected throughout the duration of the demonstration project and provide evaluations of the various physical and environmental parameters monitored. Hydrogeologic data will be used to evaluate the specific capacity and long-term yield of the two production wells; estimate radius of influence and pumping interferences of the two production wells; and provide an assessment of the interconnection between surface water and the upper and lower aquifers, if any. Any measureable land subsidence, due to the pumping of groundwater from the lower aquifer, will also be reported.

Water quality data, including EC, temperature and dissolved metals concentrations, will be summarized and evaluated relative to any noticeable changes in the habitat documented by Reclamation over the duration of the demonstration project.

9. Program Schedule

The three-year monitoring program will begin in September 2010 and will be completed by January 2013. The schedule for field sampling and data collection events is described above and summarized in Table 1. The Reclamation contractor will submit annual reports in March 2011 and March 2012, and the final report in April 2013.

Prior to the installation and development of the production wells, Reclamation will provide contractors, CDFG and other government agencies involved in the monitoring program a copy of the monitoring plan and initial monitoring program schedule. Reclamation will keep these parties apprised of any changes to the sampling schedule or project scope.

APPENDIX A

Procedure for Groundwater Level Measurement

Purpose/Application

The objective of these guidelines is to provide general reference information and technical guidance on the measurement of the depth to groundwater in an open borehole, cased borehole, monitoring well, or piezometer.

Method Summary

When measuring groundwater levels, there should be a clearly established reference point of known elevation, which is normally the top of the well casing. The reference point should be scored or permanently marked on the rim of the casing if the casing rim is not even and level. To be useful, the reference point should be tied to a USGS benchmark or a local datum. The field notes recorded should clearly describe the reference used. An arbitrary datum could be used for an isolated group of wells if necessary.

Before measurements are made within the production well casing - water levels should be allowed to stabilize for a minimum of 24 hours after well construction and development. In low-yield conditions, recovery of water levels to equilibrium may take longer. Groundwater levels should be measured and recorded to the nearest 0.1 foot. Water level measuring equipment must be decontaminated prior to and between each use. Water level readings from adjacent monitoring wells do not require that the production well be turned off. Pressure transducers placed within monitoring wells should be withdrawn periodically for cleaning and maintenance (especially when deployed in highly saline aquifers).

The condition of the wells, piezometers, or boreholes should be recorded along with the name of the individual who has measured the groundwater levels. The frequency of such measurements should be pre-established.

Limitations

These guidelines give overall technical guidance only and should be modified as necessary based upon specified requirements of project-specific plans, site conditions, or equipment limitations. Agency protocols, such as those established by the USGS, can also be substituted for these guidelines given the anticipated collaboration with the USGS on this project.

Definitions

- Water table- The surface in an unconfined aquifer where groundwater pressure is equal to atmospheric pressure.
- Potentiometric (or piezometric) surface. An imaginary surface representing the total head of groundwater in an aquifer that is defined as the level to which water would rise in a well screened at and/or beneath the water bearing zone. The water table is a particular potentiometric surface.

Equipment

- Electronic Water Level Indicator with an accuracy of 0.1 foot or a pressure transducer selected for optimal sensitivity within the appropriate hydrostatic head range (this is typically in the range of 0 -50 ft for most monitoring well applications).
- Field notebook or data logger compatible with pressure transducer selected (battery powered transducers typically use a SDI-12 or 4-20 mA sensor interface).
- Decontamination materials (deionized water and bleach or equivalent).

An electronic water level indicator consists of a spool of graduated, small-diameter cable and a probe attached to the end. When the probe comes into contact with water, the circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contact. Nine-volt batteries are typically used for a power source. Pressure transducers contain miniature strain-gauge sensors that measure changes in electrical resistance and convert these measurements into digital signals within the solid state circuitry of the instrument. These transducers can be deployed autonomously, whereby the data is downloaded from the instrument periodically through a portable interface or continuously in cases where the instrument reports to a data logger and data is downloaded directly or via telemetry from the data logger.

Procedures

The quality assurance procedures for measuring groundwater levels are as follows:

1. Check operation of equipment.
2. Clean all equipment entering the well by washing with an Alconox solution followed by a deionized water rinse.
3. Remove well cap, note well ID, time of day and date in site logbook or an appropriate groundwater level data form.
4. Ensure well is at equilibrium with atmospheric pressure. In wells with air tight plugs, or without vents, the hydraulic head may not be the same as in an open or vented well. Allow sufficient time for the well to equilibrate to atmospheric pressure. Several measurements may be needed to verify if equilibrium has been reached. This is especially important for wells screened in confined aquifers.
5. The probe should be lowered slowly into the well and once the buzzer sounds, slowly raised and lowered until the depth where the meter first creates a sound is determined. At this point, the depth to water is read directly from the graduated cable at the reference point, and recorded to the nearest 0.1 feet.
6. Pressure transducers that are either deployed autonomously or hard-wired to a data logger will collect hourly hydrostatic head measurements. Data will be downloaded at regular intervals. A barometric probe will be required if the pressure transducer probes are non-vented.

Potential Problems/Troubleshooting

When there is high or low specific conductance, groundwater cascading in the well, or a turbulent water surface in the well, measuring groundwater levels with an electronic sounder may be difficult. Before lowering the probe into the well, the circuitry can be checked by dipping the probe in water and observing the indicator. These issues are not of concern with pressure transducer sensors. However continuous sensors can drift over time and need to be checked against well soundings at least quarterly to ensure data quality. In highly saline environments even stainless steel jacketed sensors can corrode over time. Titanium instrument casings should be chosen where possible in these situations if not cost-prohibitive.

References

Fetter, C.W., 1994, Applied Hydrogeology, Third Edition, Prentice Hall Inc., pp. 691.

United States Environmental Protection Agency (USEPA) 2000, USEPA Environmental Response Team Standard Operating Procedures, Manual Water Level Measurements.

Appendix A-2

Record Form for Groundwater Level Measurement

Groundwater Level Record Form

PROJECT NAME: _____

PROJECT LOCATION: _____

PROJECT NUMBER: _____

DATE: _____

SAMPLER(S): _____

Well ID	Date	Depth to Water	Well Condition
Production Well 1			
Production Well 2			
MW-1			
MW-2			
MW-3			
MW-4			
MW-5			

PHOTO TAKEN _____ YES Photo Number:
_____ NO

COMMENTS: _____

APPENDIX B

Procedure for Groundwater Sampling

Purpose/Application

This groundwater purging and sampling procedure presents a standard method for collecting groundwater samples from production and monitoring wells that are representative of the formation from which they are being withdrawn. USGS standard protocols will be substituted where groundwater sampling is conducted in collaboration with USGS field personnel who have customized equipment and associated field techniques for collecting water quality samples.

Equipment

Production well sampling requires the following equipment:

- Flow measurement device (instantaneous and totalizing flow meter)
- Water level probe or pressure transducer
- 5-gallon bucket
- Multi-parameter water quality monitoring system

Pre-Sampling Procedures

The pre-sampling procedures for groundwater purging and sampling are as follows:

1. Position a 5-gallon bucket beneath the well's sampling port.
2. Measure and record the depth to water in the production well.

Sampling Procedures

Sampling procedures for groundwater purging and sampling are as follows:

1. Purging- Begin purging the well by opening the sampling port and allowing water to fill the 5-gallon bucket. Purge a minimum of 10 gallons of water from the well.
2. Field Parameter Monitoring- After purging 10 gallons, measure the temperature, pH, conductivity in the purge water. Continue purging, collecting one set of measurements for each 5 gallons purged. Record measurements on the field purge log. The well is ready to be sampled once a minimum of 20 gallons of water has been purged from the well and the field parameters are stable over three consecutive readings. The following criteria identify stabilized field parameters:

   ± 0.1 for pH
   ± 3.0 percent for EC
3. Sample Collection- Fill all sample containers directly from the sample port. Allow water to flow from the port, tap gently down the inside of the containers to minimize turbulence during collection. Collect groundwater samples in order of importance, according to the project requirements.

APPENDIX C

Figures for SWQDAP

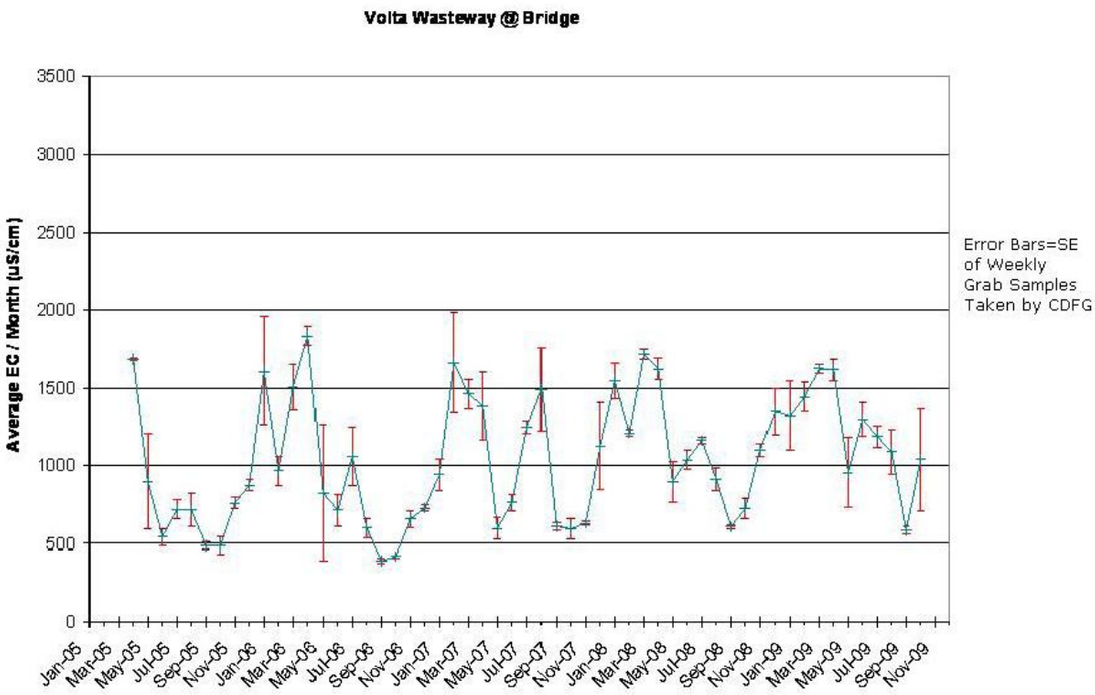


Figure 1.0 - Average EC/ Month + SE @ Wasteway Bridge

Volta Wildlife Area Level 2 Diversification/ Incremental Level 4 Development- Surface Water Quality Degradation Avoidance Protocol

AVERAGE MONTHLY EC DATA FROM WEEKLY CDFG GRAB SAMPLE DATA COLLECTED FROM WASTEWAY, VOLTA WILDLIFE AREA 2005-2009

Month	2005	SE	2006	SE	2007	SE	2008	SE	2009	SE	MAX EC 2005-2009	SE	MAX EC+ SE 2005-2009
Jan	n/d	n/d	1607	349	942	100	1550	117	1321	224	1607	349	1956
Feb	n/d	n/d	966	96	1664	318	1409	202	1446	92	1664	318	1982
Mar	n/d	n/d	1510	148	1465	94	1721	33	1627	29	1721	33	1754
Apr	1690	9	1836	59	1387	223	1625	71	1620	71	1836	59	1895
May	897	308	824	436	597	66	897	130	744	86	897	223	1120
June	543	53	712	105	762	54	1038	61	1299	114	1299	114	1413
July	718	62	1059	186	1246	39	1161	19	1187	70	1246	39	1285
Aug	713	105	598	63	1492	268	912	74	1089	145	1492	268	1760
Sep	489	23	389	20	610	22	606	10	583	23	610	22	632
Oct	487	54	418	8	594	65	725	66	1038	330	1038	330	1368
Nov	760	39	658	53	629	13	1100	41	1250	189	1250	189	1439
Dec	875	40	728	23	1126	283	1350	150	1834	90	1834	90	1924

Monthly Avg Max EC Threshold = Max Monthly Avg EC + Max Standard Error observed from 2005-2009 = Pumping Ceases
Pumping will CEASE at Production Wells if Monthly Avg Max EC Threshold is exceeded until Wasteway EC conditions improve

Max Monthly Avg EC Observed from 2005-2009- Pumping Proceeds with Caution

< Max Monthly Avg EC Observed from 2005-2009 - Pumping OK

Month = Pilot Project Year 1 pumping duration - Giant Garter Snake Prey Avoidance Period; Goal 2,000 Acre ft

EC Measure Downstream of Production Wells

SE= STANDARD ERROR (Corresponding SE to Max Observed EC 2005-2009)

nd= NO DATA

FIGURE 2.0 - SWQDAP Table

Volta Wildlife Area Level 2 Diversification/ Incremental Level 4 Development- Surface Water Quality Degradation Avoidance Protocol

Actual EC- From CDFG Weekly Grab Sample Data 2005-2009

THRESHOLD- From Maximum Observed Monthly Average EC 2005-2009 + Standard Error 2005-2009

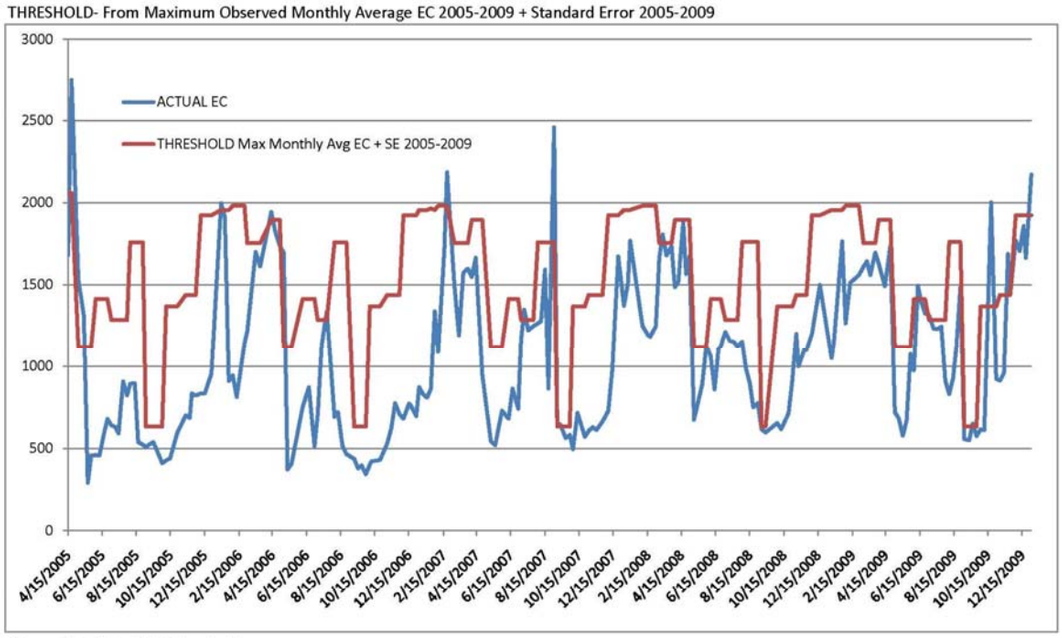


Figure 3.0 - Actual Vs. Threshold

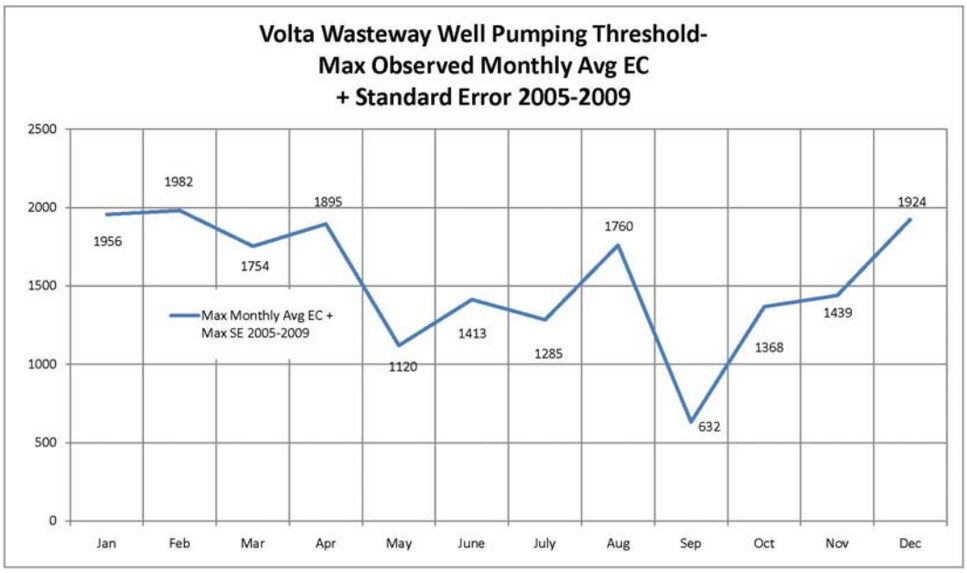
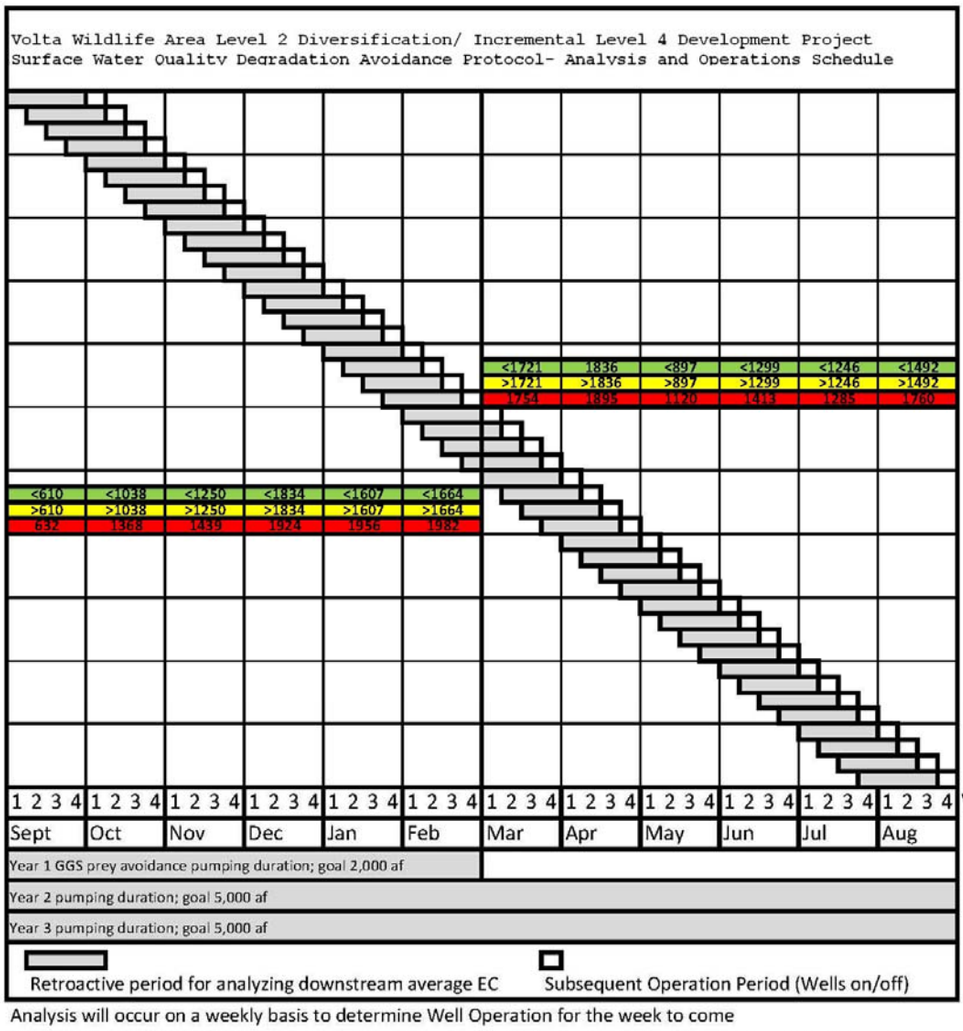


Figure 4.0 - SWQDAP Monthly Thresholds



Analysis will occur on a weekly basis to determine Well Operation for the week to come

Four Week Running Avg EC from weekly downstream samples compared to Monthly Average Max EC Threshold

Monthly Average Max EC Threshold derived from Volta Wasteway monthly Average EC & SE data from 2005-2009

See Attached Figure 2.0- Volta SWQDAP Table and Figure- 4.0 Monthly Threshold Graph

<Maximum observed monthly average EC 2005-2009- Pumping OK
>Max Monthly Avg EC Observed from 2005-2009- Pumping Proceeds with Caution
Monthly Avg Max EC Threshold = Max Monthly Avg EC + SE observed from 2005-2009 = Pumping Ceases
Pumping will CEASE if Monthly Avg Max EC Threshold is exceeded until Wasteway EC conditions improve
af = Acre Feet
EC = Electro-Conductivity
GGS = Giant Garter Snake *Thamnophis gigas*
SE= Standard Error

Figure 5.0- SWQDAP Analysis and Operation Schedule

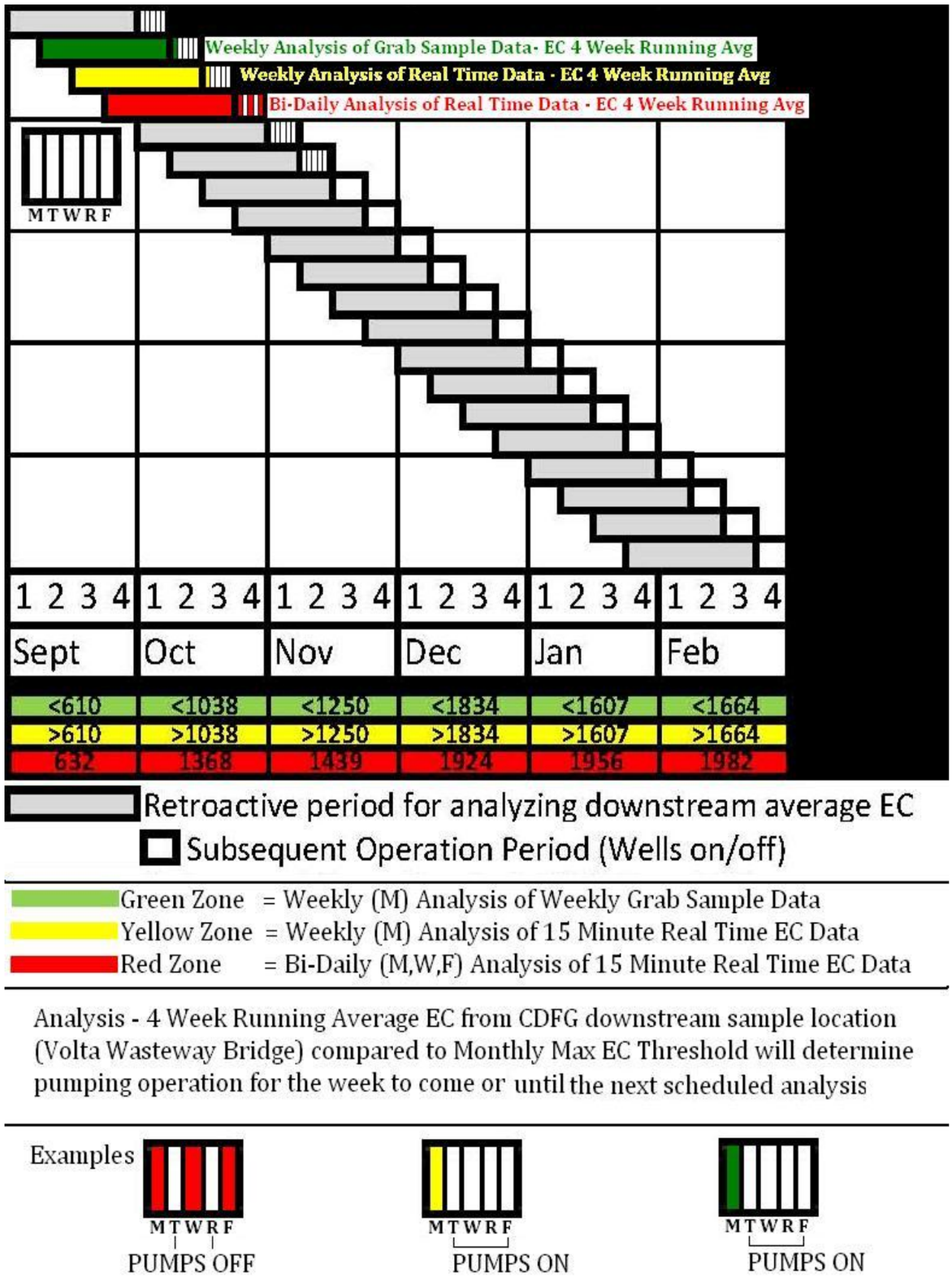


Figure 6.0- SWQDAP Conditional Real Time EC Data Analysis